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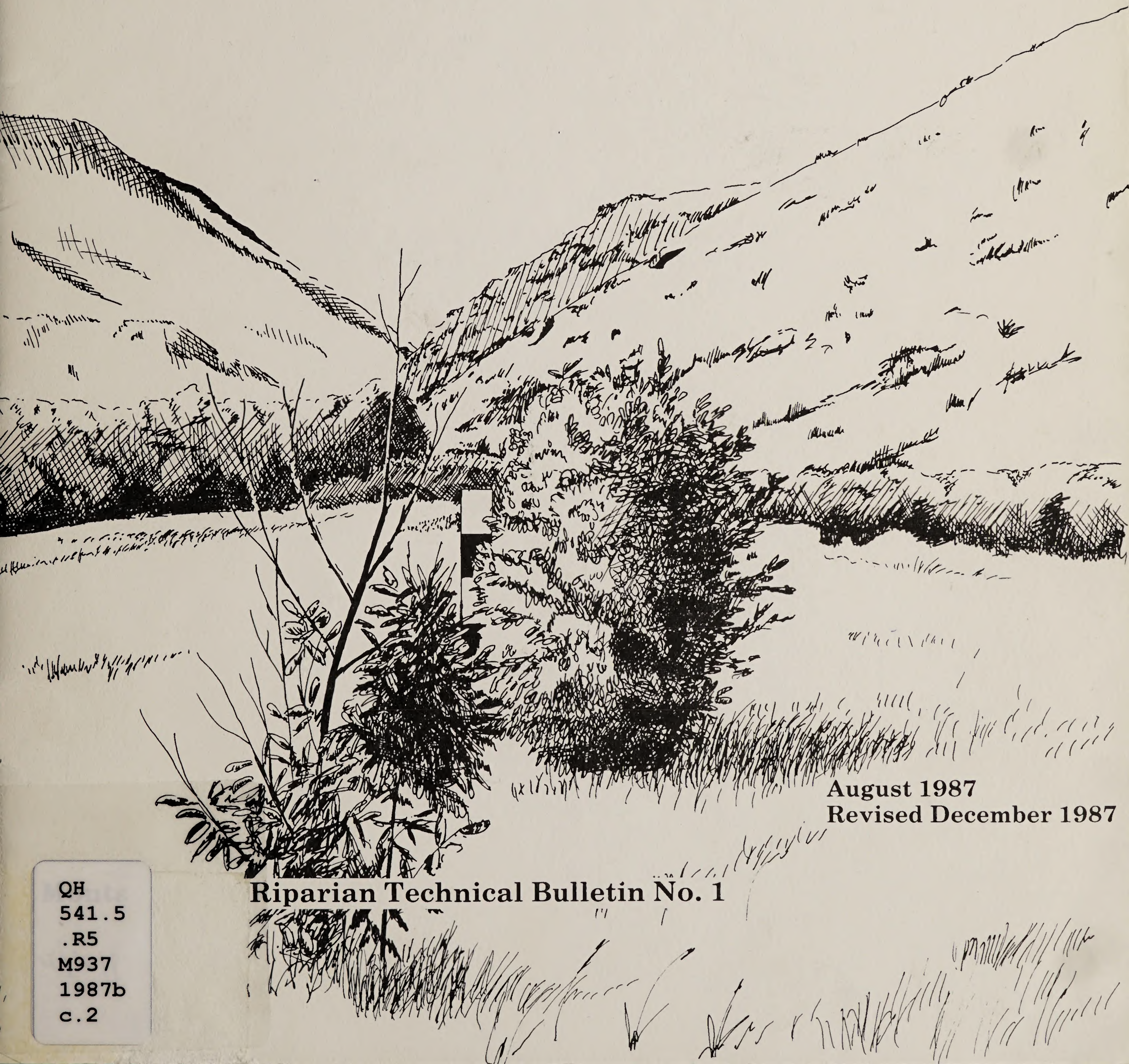

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Riparian Technical Bulletin No. 1

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FOREWORD

This Tech Note describes the techniques used for inventorying and monitoring riparian sites in the Dillon Resource Area in Southwestern Montana. The condition and vigor of deciduous woody, wetland species were found to be valid indicators of general riparian site conditions and trend and provided adequate data for most management situations.

These techniques were not developed with Bureau-wide application in mind. Application in areas outside of southwest Montana may necessitate modifications to reflect regional differences. The ideas presented here may have some value in assisting managers in formulating their own inventory and monitoring programs.

CONTENTS

Introduction 1
Section I. Woody Riparian Inventory 1
Section II. Woody Riparian Trend Transects Using Cover Boards and Photographs 17
Section III. Intensive Riparian Inventories and Monitoring 23
Section IV. Literature Cited 29
Section V. Appendix 1, copies of field forms and Figures 5 and 6 for copying and use in the field 31

Tables

Table 1. Approximate Step Intervals for Various Sample Sizes for Woody Riparian Inventories, BLM Dillon Resource Area, Montana. 3
Table 2. Basal Diameter vs. Age of Woody Riparian Species, BLM Dillon and Headwaters Resource Areas, Montana. 6
Table 3. Example of the Use of Comparison Area Stream Reaches in Establishing Rating Criteria, BLM Dillon Resource Area, Montana. 10
Table 4. Comparison Area Data (Confidence Intervals) Used for Riparian Rating Criteria, BLM Dillon Resource Area, Montana. 11

Field Forms

Field Form 1. Woody Riparian Survey, BLM Dillon Resource Area, Montana. 4
Field Form 2. Example of Woody Riparian Trend Transect, BLM Dillon Resource Area, Montana. 18
Field Form 3. Summary and Analysis of Woody Trend Transect Data from Field Form 2, BLM Dillon Resource Area, Montana. 20
Field Form 4. Example of Vertical Foliar Cover Analysis (T-test), BLM Dillon Resource Area, Montana. 22
Field Form 5. Summary of Large Quadrate Data for a Shrub Species, BLM Dillon Resource Area, Montana. 27

Figures

Figure 1. Riparian Characteristics Compared on an Unmanaged Stream and a Well Managed Stream, BLM Dillon Resource Area, Montana. 13
Figure 2. Relationship (linear regression) Between Riparian Rating and Bank Erosion. 15
Figure 3. Photograph of Typical Cover Board Transect on Aspen. 19
Figure 4. Woody Vegetative Profile for Dyce Creek, BLM Dillon Resource Area, Montana. 21
Figure 5. Example of a "Treasure Map" and Recordation for 2 x 5 dcm. Quadrates, BLM Dillon Resource Area, Montana. 24
Figure 6. Example of a "Treasure Map" and Recordation for 4 x 8 M Quadrates, BLM Dillon Resource Area, Montana. 25

Appendix

Appendix 1. Field forms 1 through 5 and Figures 5 and 6 for copying and use in the field. 31

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Riparian Inventory and Monitoring

Bureau of Land Management
Dillon Resource Area

Lewis H. Myers

August 1987
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Introduction

The approach used in riparian inventory and monitoring in the Dillon Resource Area since about 1976 is described. Routine inventory and monitoring work relied primarily upon assessments of woody wetland species vigor and growth. Emphasis was placed upon use of woody species because (1) they dominate the vegetation aspect of Dillon area riverine riparian sites; (2) they are efficient to study/monitor; (3) they are generally valid ecological indicators of riparian site condition; (4) they exert significant influence on riparian floodplain function; (5) they are palatable and reflect livestock and big game grazing influences; (6) they have high resource values and (7) nonskilled volunteers or seasonal employees may be used with less training as compared to that required for vegetation composition studies.

More intensive inventory/monitoring efforts requiring vegetation composition data were limited to special priority management situations and for special study sites where recovery rates and potential natural community data are needed.

The approach used in monitoring/inventory was necessitated in large part by limited workforce capability and a need to provide some riparian management input for about 200 livestock grazing allotments.

This report has three detailed sections: Section I, Woody Riparian Inventory; Section II, Woody Riparian Trend Transects Using Cover Boards and Photographs; and Section III, Intensive Riparian Inventories and Monitoring.

Examples of Field Forms 1 through 5 and Figures 5 and 6, with actual data recorded on them, are used in the body of the document. Appendix 1 provides these forms for copying and use in the field.

Section I. WOODY RIPARIAN INVENTORY

I. Purpose and Application

This routine inventory should eventually be completed on each stream reach. It serves as the base for establishing the *general* condition and formulating priorities for riparian management or possibly more intensive inventory. It is recognized that condition as expressed by woody vigor may only be "in the ballpark." More detailed inventory data, i.e., composition, should be collected if required, where resource values and/or conditions dictate (see Section III).

Data collected from this inventory along with the use of comparison areas is useful for developing short term woody riparian management objectives. An example of typical objectives useful in allotment management plans (AMPs) follows:

a. Increase *Salix boothii* canopy from 10% to 40%.
b. Increase *Salix boothii* regeneration (1-10 mm size-age class) from 1% to 15% or more.
c. Reduce dead/decadent *Salix* plants from 50% to 10% or less.
d. Reduce heavily hedged *Salix* plants from 80% to 40% or less.
e. Increase *Salix boothii* density from .01 plants/m to at least .15 plants/m.

Where resource values dictate, the woody inventory may be replicated after time as a monitoring technique.

This extensive technique is suited to analysis of perennial, intermittent, or ephemeral flow streams where deciduous woody, wetland species dominate the vegetation aspect. The survey was found to apply to almost all foothills habitats in southwestern Montana. This includes sagebrush steppe, foothills prairie, Douglas-fir forest, and western spruce — fir forest associations identified by Kuchler (1964). Foothill riparian habitats in this area are dominated by willows (*Salix spp.*), with mixtures of aspen (*Populus tremuloides*), dogwood (*Cornus sericea*), maple (*Acer glabrum*), alder (*Alnus sinuata),* birch (*Betula glaudulosa, B. occidentalis*), cottonwood (*Populus fremontii*) and rose (*Rosa* woodsii). Occasionally conifers, such as Douglas-fir (*Pseudotsuga menziesii*), spruce (*Picea engelmannii*), alpine fir (*Abies lasiocarpa*), Rocky Mountain juniper (*Juniperus scopulorum*), and common juniper (*J. communis*) are intermixed. The inventory does not apply to closed canopy conifer sites. Likewise, it may be of doubtful value in stands dominated by mature aspen where canopy is sufficiently dense to impair reproduction.

The basic assumption is that condition and vigor of woody, wetland species are valid indicators of riparian site condition. Values of herbaceous species in riparian ecosystem productivity, bank building processes and sediment entrapment are recognized. However, woody species are more efficient to analyze when workforce is a major limiting factor. A basic disadvantage of the survey is its inapplicability to riparian reaches lacking woody, wetland species, though these are rare in southwestern Montana.

The inventory is a valuable supplement to stream surveys (BLM Manual 6671. 1973), channel stability surveys as described by Pfankuch (1975), water quality evaluations on streams (BLM Manual 6674. 1975), and more intensive composition inventories.

II. Methods

A. Pre-survey Analysis

Stream reaches are tentatively identified on U.S.G.S. quadrangle maps or on aerial photographs. Color infrared photography is particularly well suited to this. All known fences, grazing allotment boundaries, and pastures must be plotted on quadrangle maps or aerial photo overlays. A reach is defined as a synonymous riparian ecological site within a management area, such as a pasture or grazing allotment. In no case does a survey reach extend beyond a fenced management pasture or allotment. Individual pastures are often managed differently within a system. Thus, a reach always terminates when a fence is encountered. However, more than one reach may occur within a pasture if the site changes substantially.

A riparian reach number should be assigned. Reach length is measured with a map measuring tool and recorded. This allows selection of a sample step interval which will provide a minimum of 20 sample quadrates per reach. Where stand variability appears high, coefficient of variation should be evaluated for several survey parameters in the field to ensure adequate sample size (see The Lighter Side of Statistics, Eshelman et al. 1986).

B. Inventory

1. Inventory Area

The inventory area consists of the upper streambank. This is defined as the area between the normal high waterline and the next break in the topography. Where this cannot be readily identified, the general rule is to hug the high waterline. Woody species providing bank protection are most pertinent to evaluation of grazing impacts. Woody plants well away from the banks are much less significant to the riparian site productivity and stability.

On streams large enough to constitute barriers to livestock, record the side surveyed. Each side constitutes a separate survey reach. On small streams, survey both sides by crossing the stream after each quadrate is recorded.

The surveyor walks along the upper bank area, and at the predetermined step interval (see Table 1), establishes one corner of a 4 x 8 meter quadrate. The long axis parallels the stream. Wooden laths and a cloth tape are used to temporarily establish the quadrate area.

TABLE 1. APPROXIMATE STEP INTERVALS FOR VARIOUS SAMPLE SIZES FOR WOODY RIPARIAN INVENTORIES
BLM, Dillon Resource Area, Montana.

	Number of Quadrates		
Reach Length	**N=20**	**N=25**	**N=30**
0.25 miles	24	19	16
0.50 miles	48	38	32
1.00 miles	94	75	63
1.25 miles	118	94	79

Provision is made for 2 x 8 meter quadrates in narrow riparian zones. Quadrate size must be recorded on the form and remain constant throughout a survey reach. Each inventory parameter on the form is recorded at this sample point.

2. Inventory Species

This inventory includes only woody wetland species classified by the Wetland Ecology Group (Reed, 1986) as *facultative wetland* or *obligate* species. Examples include willows (*Salix spp.*), dogwood (*Cornus stolonifera*), alders (*Alnus spp.*), birches (*Betula spp.*), and black cottonwood (*Populus trichocarpa*). Non-wetland species not included in the inventory were currants (*Ribes spp.*), chokecherry (*Prunus virginiana*), cinquefoil (*Potentilla fruticosa*), rose (*Rosa woodsii*), maple (*Acer glabrum*) and Englemann spruce (*Picea engelmanii*). Aspen (*Populus tremuloides*), though not a wetland species, was included in inventories due to its priority in management.

Wetland species can be identified with the assistance of Regional Wetland Plant lists prepared by the Wetland Ecology Group (Reed, 1986), U.S. Fish and Wildlife Service.

3. Equipment

The woody riparian survey form (Field Form 1), map or aerial photo, plastic flagging, clipboard, single lens reflex camera, hand counter, pocket calculator programmed for mean and standard deviation, coefficient of variation curves for 80% confidence level (Lighter Side of Statistics, Eshelman et al. 1986) and a lath measuring stick are the only materials needed. A measuring stick is easily made by marking 1-10 millimeter and 11-15 millimeter intervals on the square end of a piece of lath. A blunt, felt-tip marker and plain paper or BLM form 4412-16 are required when taking photographs. Commercially available black background boards with white replaceable letters are photographically superior.

4. Photographs

When starting and terminating reach inventories, take one photograph upstream and one downstream. An additional photograph across the stream is optional. Permanent stakes can be utilized, if desired. Additional photos should show typical areas and special problem areas. All photo locations should be shown by number on the map or aerial photo. The photo form must be placed in the foreground when taking photos, and the reach number and date must be clearly legible.

Field Form 1.

WOODY RIPARIAN SURVEY, BLM Dillon Resource Area, Montana.

STREAM: Example Cr STEP INTERVAL 94 QUADRATE SIZE ___ 2 x 8 M X 4 x 8 M ADP NO. 5S-10W-1-1
REACH NO. TE-9 REACH LENGTH 1.0 (mi.) 1609 (meters) BEGIN: NW NE SW Sec. 1 T. 5S R. 10W
DATE: 8-3-86 INVESTIGATOR: L. Myers END: NE NW SW Sec. 6 T. 5S R. 9W
PLANT SAMPLE SIZE: 230 NO. QUADRATES: 20 REACH CONDITION: low fair

WOODY SPECIES	SIZE CLASSES	DENSITY TALLY	WOODY SPECIES FORM CLASSES: UNAVAILABLE < 1.5M	UNAVAILABLE 1.5M >	NORMAL < 1.5M	NORMAL 1.5M >	HEAVILY HEDGED < 1.5M	HEAVILY HEDGED 1.5M >	DECADENT < 1.5M	DECADENT 1.5M >	DEAD < 1.5M	DEAD 1.5M >	HEDGED DEAD < 1.5M	HEDGED DEAD 1.5M >	SIZE CLASS SUMMARY: EACH SPECIES DENSITY/ %	ALL SPECIES DENSITY/%
Saex	1-10 mm	☒	·		·		⁘						∴		0.01/3.9	0.013/ / / 4.7%
Sabo		:					·						·		0.003/0.8	
															/	
															/	
Saex	11-15 mm	☒ ☒ ∴	·		·	:		☒ 1:	·	·		·	·		0.03/10.0	0.08/ / /25.7%
Sabo		☒ ☒ ☒ L:				☒	⁘	☒ ·	·	∴			∴	⁘	0.05/15.7	
															/	
															/	
Saex	> 15 mm	☒ ☒ ☒ ☒ ☒ ☒ ☒ □		:		☒ ☒	L:	☒ ☒ ☒ ∴		☒ ·		⁘	·	·	0.12/33.9	0.25/ / /69.6%
Sabo		☒ ☒ ☒ ☒ ☒ ☒ ☒ ☒ :		⁘		☒ ☒ ·		☒ ☒ ☒ ☒ ⁘		L:		∴		⁘	0.13/35.7	
															/	
															/	
			3.5%		23.9%		51.3%		10.0%		3.5%		7.8%			

	DROPPINGS COUNT	DROPPINGS PER HECTARE
CATTLE	318	986
ELK	0	0
DEER	19	59
MOOSE	0	0

DROPPINGS AREA = 2 m x REACH
LENGTH 1609 m = 3218 m^2

PERCENT HEIGHT CLASSES
< 1.5 m 13%
> 1.5 m 87%

RIPARIAN WIDTH (m)
8, 12, 9, 15, 13, 20
38, 42, 16, 11, 21,
18, 17, 23, 17, 19,
20, 20, 13, 15

AVG: 18.4

RIPARIAN AREA = TOTAL AVG.
WIDTH 18.4 m x TOTAL LENGTH
1609 m = $\frac{29605 \text{ m}^2}{10{,}000}$ =
2.96 hectares

TOTAL WOODY SPECIES DENSITY (NO/METER)

SPECIES	DENSITY
Saex	0.16
Sabo	0.18

Field Form 1. (continued) REACH NO: TE-9

SPECIES	USE CLASS - % AVAILABLE LEADERS CLIPPED 0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	SPECIES USE %
Saex			:		:	:	☒.	:.				50
Sabo	:		.	.		::	☒	:	.			46.5
MIDPOINT	0	5.5	15.5	25.5	35.5	45.5	55.5	65.5	75.5	85.5	95.5	

PHOTOGRAPHS No.	LOCATION; DESCRIPTION
14	Start, looking upstream
15	Start, looking downstream
16	Typical riparian from fence corner SWNE Sec 6
17	End, looking upstream
18	End, looking downstream

SPECIES	WOODY CANOPY COVERAGE CLASSES 0	1-5	5-25	25-50	50-75	75-95	95-100	AVERAGE CANOPY	POTENTIAL CANOPY
Saex	1:	:	1:	☐				19.1	25
Sabo	:	::	:	☒	.	.		28.2	40
MIDPOINT	0	3	15	37.5	62.5	85	97.5	Total 47.3	Total 65

BANK ROCK CONTENT	TALLY	PREDOMINANT SIZE (✓)
65% large angular boulders 3 dcm +	:	
40-65% mostly small 1½-3 dcm cobble	☒ :.	✓
20-40% with most in 1-1½ dcm size	::	
< 20% rock, mostly gravel size	.	

WETTED CHANNEL WIDTH (meters, cm)

2.0, 2.7, 2.1, 1.8, 3.1,
3.3, 1.9, 1.7, 2.6, 1.9,
2.4, 2.7, 2.3, 3.4, 3.1,
2.3, 2.1, 3.0, 1.6

AVG: 2.4

EROSION SOURCE	ACTIVE BANK EROSION 0	10	20	30	40	50	60	70	80	90	100	AVERAGE EROSION	TOTAL EROSION
LIVESTOCK	.	:	::	☒ .	.		.					26.5	29%
HYDROLOGIC	☒ ☐	.	.									1.5	
HUMAN	☒ ☒		.									1	
WILDLIFE	☒ ☒											0	

NOTES: Woody regeneration heavily hedged. Woody plants 5-8 years old apparently established following past beaver activity (inactive dams) and prior to the existing grazing system. Grazing system should be changed.

5. Shrub Criteria

Plants *rooted* within the quadrate area are placed in a size class, a form class, and a height class. Dot tallies save space. Definitions follow.

a. Size class is determined by measuring the basal diameter just above ground level (within 2 inches) of the largest *live* stem on the plant. Each plant is placed into one of three size-age classes, 1-10 mm, 11-15 mm, and greater than 15 mm. Data on size-age relationships for various woody species are shown in Table 2. Plants 10 mm or less in diameter are approximately 1-5 years of age, and plants 11-15mm in diameter are approximately 5-7 years of age. This provides an adequate index of regeneration.

TABLE 2. BASAL DIAMETER VS. AGE OF WOODY RIPARIAN SPECIES BLM, Dillon and Headwaters Resource Areas, Montana.

AGE	N	DIAMETER MEAN (MM)	C.I. (95%)	CORRELATION COEFFICIENT (r)
Salix boothii and *S. geyeriana*				
2	6	7.83	±1.32	
3	17	8.94	±1.14	
4	13	8.61	±2.02	
5	10	12.6	±2.59	
6	8	13.62	±4.53	
7	11	13.81	±4.97	
8	9	19.00	±8.15	
9	11	18.27	±4.67	
10	4	17.25	±7.41	
11	2	24.00	±4.24	
	91			r = 0.9503
Populus tremuloides				
5	8	9.63	±2.60	
6	7	13.28	±2.87	
7	6	13.80	±2.85	
8	5	20.60	±11.08	
9	3	22.00	±3.00	
10	4	22.25	±6.40	
11	2	24.00	±4.25	
	35			r = 0.9576
Betula occidentalis				
4	8	9.62	±3.29	
5	5	13.40	±3.36	
6	6	11.33	±2.65	
7	2	16.00	±2 82	
8	3	14.00	±6.24	
9	2	17.00	±7.07	
11	4	19.50	±8.42	
12	3	18.66	±4.04	
19	2	52.50	±34.64	
	35			r = 0.9242

TABLE 2 (Continued)

Cornus stolonifera				
2	2	3.50	±6.40	
3	4	7.80	±0.41	
4	5	9.20	±0.71	
5	6	10.33	±0.64	
6	6	14.62	±0.82	
7	4	14.73	±0.35	
8	6	16.80	±0.54	
10	6	20.62	±0.44	
12	6	24.64	±0.82	
	45			r = 0.9823
Alnus spp.				
2	3	5.13	±2.37	
3	4	5.55	±1.46	
4	6	6.73	±0.78	
5	6	7.53	±1.06	
6	7	8.39	±0.73	
7	6	12.08	±1.30	
8	6	13.00	±0.75	
9	3	14.00	±1.24	
10	4	16.25	±1.03	
12	3	18.50	±2.48	
13	2	23.00	±12.70	
16	3		±3.13	
	53			r = 0.9870

b. A plant can be placed in only one of the following form classes.

i. *Normal:* plants have fewer than 50% of the second year and older leaders (ignore current annual growth) clipped and are neither decadent nor dead.

ii. *Unavailable:* plants provide no browsed or unbrowsed forage below 1.5 meters in height, or are unavailable by virtue of their location or protection by other plants.

iii. *Hedged Dead Plants:* those obviously killed by excessive hedging.

iv. *Heavily Hedged Plants:* those with 50% or more of the available second year or older (not current annual growth) leaders clipped. Normally, bifurcation at the next lowest buds occurs when terminal buds are clipped. This is the best indicator of clipping. Numerous branches should be inspected. *Do not* consider leaders which are unavailable due to height (above 1.5 meters) or position (overhanging deep water, etc.). If all live leaders are unavailable, the plant cannot be heavily hedged. Hedging can be attributed to livestock, big game, beaver, or any combination. Heavily hedged plants may also qualify as decadent, but they are recorded as hedged.

v. Decadent: plants have 30% or more of the crown area dead. A decadent plant which is also heavily hedged is recorded as hedged.

vi. Dead: plants have no live tissue, but remain standing.

c. Height classes of <1.5 m or >1.5 m are established to distinguish between all available and partly available plants for most large ungulates. On most people, 1.5 meters is roughly eye height. Where better data are required, heights may be measured for each plant within quadrates. Under each form class on Field Form 1, data are entered under a < or > subheading, designating shrub heights as less than 1.5 m or greater than 1.5 m, respectively.

6. Density

Wetland, woody plants *rooted* within the quadrate are recorded by species and size-age class under the density tally column. Dot counts save space.

Calculations of density (plants/meter) include each species within a size class, all species within a size class, and the total density of each woody species irrespective of size class. Total woody density irrespective of species can be calculated by adding species densities. The percentage of plants in each of these categories is also calculated.

7. Canopy Measurements

Canopy coverage of wetland, woody species only, is measured at each predetermined step interval. Canopy estimates are made by coverage class as described by Daubenmire (1959), with the addition of a zero (0) category. A 4 x 8 meter modified Daubenmire quadrate is established by stretching a cloth tape around a wooden lath. Where the riparian site is narrow, a 2 x 8 meter quadrate is used. Quadrate size must be recorded on Field Form 1, and must remain the same throughout the reach. It is critical that bias not be induced in selecting the quadrate corner. In making canopy estimates, the surveyor can climb to a higher ground level, if desired, to look down upon the quadrate. The quadrate can also be subdivided mentally, or with string or flagging, to assist in canopy estimates. After recording 15 quadrates, calculate the coefficient of variation (CV) for canopy of the most common woody specie. Verify the sample size required before proceeding (see The Lighter Side of Statistics, Eshelman et al. 1986).

8. Bank Erosion

Active bank erosion is estimated each time a quadrate is established. Active erosion is defined as unstable bank area. Raw exposed soil areas where cutting occurs during peak flows are generally obvious. Also included are areas so severely trampled by animals that physical detachment is occurring or anticipated in the forthcoming peak flow. Bank sloughing and undercut failures are included.

Dished out areas where severe past erosion has occurred may be characterized by aggregate and rubble compositions and gentle slopes. Such areas generally are not actively *eroding*, though they are *eroded*. An ocular estimate is made of the percentage of *total bank area* seen which is actively eroding, by looking up and down the stream.

While walking between sample points, *constant attention* must be given to bank erosion, allowing adjustments when estimates are recorded. One bank equals 50% of total bank area. Thus if 20% of one bank is eroding, and the other bank is entirely stable, a 10% estimate is recorded.

Where more detailed data are required, eroding bank linear distance can be measured and expressed as a percentage of total bank length.

9. Bank Rock Content

This is recorded with a dot each time bank erosion is observed. These criteria follow those used by Pfankuch (1975) in stream channel analysis. Upon completion of the survey, a large "X" should indicate the bank rock class most characteristic of the entire reach.

10. Riparian Community Width

Excluding the stream channel, the width is paced on both sides, and the sum recorded. This is done at each quadrate sample point. When more detailed data are required, this distance may be measured and even permanently monumented for trend purposes.

11. Wetted Channel Width

This is measured and recorded at each quadrate sample point.

12. Potential Canopy Coverage

This should be estimated upon completion of the survey, *in the field*. Generally, this requires experience in surveying other similar reaches plus the use of comparison areas which are well managed or protected by exclosures. Fenceline contrasts are particularly useful. Consider the percentage of hedged plants and the percentage of bank area which would be occupied by suppressed reproduction. Also consider existing canopy. Generally, woody canopies greater than 75% are rare. Consider herbaceous production. Dense herbaceous growth often impairs establishment of woody species seedlings. Coarse and rocky soils, abandoned beaver dams, sand bars, and channel changes are sites with woody regeneration potential.

It may be useful to make estimates of the anticipated percentage increase. Judgment tempered by experience and consideration of survey data is required. Even though subjective in nature, it is valuable to know if substantial canopy increases may be anticipated.

13. Survey Notes

Record notes on back of survey form. Always document presence or absence of stock, big game, beaver activity, etc. Other important observations which may assist in interpreting the data should also be recorded such as frost pockets, diseases in woody plants, channel changes, and livestock distribution problems.

14. Droppings

This may be useful where livestock versus big game riparian impacts are an issue. Upon completion of the survey, walk back along the same reach. Tally all livestock and big game droppings on a belt transect 2 meters wide (measured by outstretched arms). Compute droppings per hectare by multiplying 2 meters times reach length in meters, and dividing by 10,000. Record all droppings, irrespective of age.

15. Utilization

Utilization is not routinely recorded in the inventory, and may be more pertinent to monitoring. It may be necessary to distinguish between livestock and big game use in certain areas. In most cases, this requires sampling in at least two different time periods. No effort is made to accurately quantify utilization. On woody species, an estimate of the percentage of available leaders, "clipped" or grazed, is an index to actual utilization by weight. More refined measurements of utilization based upon the percentage used by weight may be used if necessary, but such efforts are quite time consuming.

It is not recommended that herbaceous species utilization be measured, but rather post growing season *residual height* following grazing use. Utilization during the growing season may have little management significance due to rapid regrowth and a prolonged growing season in riparian sites. Herbaceous cover remaining through winter (insulative, cover, etc.) and spring (sediment entrapment, riparian function, etc.) is most pertinent to management. Herbaceous residual height is recorded under notes.

16. Riparian Area

This is the product of the map length and the mean riparian community width. This may have value in assessing wildlife habitat values for certain species and vulnerability to adverse resource use impacts.

C. Rating Reaches

The first step is to establish *local* criteria using comparable riparian sites judged to be in good condition. Exclosures, protected (fenced) streams, and exceptionally well managed areas are required. Ideally, a quality rating should be developed for each riparian ecological site in the region. A 95% confidence interval of mean characteristics for good condition reaches establishes the good category for each rating parameter (Table 3). Rating parameters include normal plants, hedged plants, dead and decadent plants (combined), canopy coverage, reproduction, and bank erosion. An example of the use of confidence intervals as a rough riparian rating system in the Dillon Resource Area is shown in Table 4. Artificial ratings such as these must always be tempered by professional judgment and not utilized in "cook book" fashion. A conscientiously applied rating should only be used to *aid* the manager.

TABLE 3. EXAMPLE OF THE USE OF COMPARISON AREA STREAM REACHES IN ESTABLISHING RATING CRITERIA
BLM Dillon Resource Area, Montana.

	Plants (%) in Each Form Class				Plants (%) in Each Basal Diameter Size Class				
Reach Numbers[1]	Normal	Hedged	Decadent	Dead	1-10 mm	11-15 mm	>15 mm	Woody Canopy (%)	Bank Erosion (%)
R-1	67	19	7	8	12	15	73	73	4
R-2	88	23	4	8	19	14	68	75	12
R-3	58	33	4	4	3	9	87	56	12
R-4	77	16	5	2	14	15	71	70	5
R-9	72	29	0	0	23	24	54	69	15
R-15	73	16	7	5	3	11	87	76	4
R-17	82	18	1	0	23	27	50	50	4
R-12	71	10	8	11	2	10	88	70	20
Mean	X	X	X	X	X	X	X	X	X
	71	20.5	4.5	4.2	12.4	15.6	72.2	67.4	9.5
Conf. int. (95%)	±6.9	±7.3	±2.8	±3.7	±8.7	±8.4	±14.5	±8.5	±5.8

[1] These eight reaches were selected because they were in very good or excellent ecological condition and met or exceeded wildlife habitat objectives. See Table 4 for the use of confidence intervals in rating criteria.

In developing the rating system, canopy coverage was weighted 3 times greater than other parameters. In this way, a reach with a dense canopy cover rated better than a reach with a sparse canopy, but with identical vigor characteristics. Reaches were rated as poor, fair, good, or excellent.

Once reaches are rated, the land manager can decide if poor or fair ratings are satisfactory or unsatisfactory in terms of meeting various resource goals. In the rating used, bank erosion of 40% or more and dead-decadent compositions more than 30% mandated "unsatisfactory" reach ratings. A score was still computed, however.

In some cases, reaches with high bank erosion may rate "unsatisfactory," but "good" in vegetative characteristics. This is a good indication of off-site problems, such as upstream watershed condition. Reaches rating "unsatisfactory" due to dead-decadence may have good rating in form class and reproduction. This can be an indicator of drastic changes in management, or past artificial treatments such as spraying.

TABLE 4. COMPARISON AREA DATA (CONFIDENCE INTERVALS) USED FOR RIPARIAN RATING CRITERIA
BLM Dillon Resource Area, Montana.

Parameter	Confidence Interval			Score
NORM	> 78%			3
	64-78%			2
	50-63%			1
	< 50%			0
HEDGED	< 14%			3
	14-28%			2
	29-50%			1
	> 50%			0
DEAD & DECADENT	< 2%			3
	2-16%			2
	17-24%			1
	25-30%			0
	> 30%			U
CANOPY	> 76%			9
	59-76%			6
	30-58%			3
	20-29%			1
	< 20%			0
REPROD	1-10MM	11-15MM	15MM	
	> 21%	> 21%	< 58%	3
	4-21%	9-21%	58-87%	2
	1-4%	4-9%	87-96%	1
	< 1%	< 4%	> 96%	0
EROSION	< 4%			3
	4-15%			2
	16-30%			1
	31-39%			0
	>40%			U

Instructions:
Rate each parameter as shown and add the cumulative score. In a few cases, age classes will fall into different score brackets; score reproduction in the bracket in which *two* of the three categories fall.Any reach with more than 30% dead and decadent or 40% or more bank erosion routinely rates unsatisfactory (U) irrespective of total score. The total score is a good indicator to determine if the "problem" is on-site or off site in origin.

Excellent =	19-24 Points
Good =	10-18 Points
Fair =	7-9 Points
Poor =	<7 Points

In developing the rating system, canopy coverage was weighted 3 times greater than other parameters. In this way, a reach with a dense canopy cover rated better than a reach with a sparse canopy, but with identical vigor characteristics. Reaches were rated as poor, fair, good, or excellent.

III. Discussion and Use of Woody Data

Woody species analysis is sufficient to make a general assessment of riparian vegetation condition. Given limited manpower, this allows the manager to select priority streams for additional, more intensive analysis (see Section II). On some streams, the extensive woody riparian inventory may be all that is required to verify the lack of a management problem.

Aging of woody species indicate that the basal stem diameter (B.S.D.) classes are statistically valid indicators of age (Table 2). Correlation coefficients between age class and diameter for willow, aspen, birch, alder, and red dogwood range from 0.9242 to 0.9870 (valid at 99.9%). Generally, plants within the 1-10 mm diameter class are 1-5 years of age. These young plants are of particular importance in management, since they are the most preferred by browsing animals (game and stock), the most vulnerable to browsing, and they constitute the recruitment for the woody species. Generally, young plants should equal or exceed dead-decadent plants in order to maintain or improve the woody composition. The exception to this is in streams with dense woody canopies (generally 60% or more), where competition for space and sunlight impairs woody regeneration.

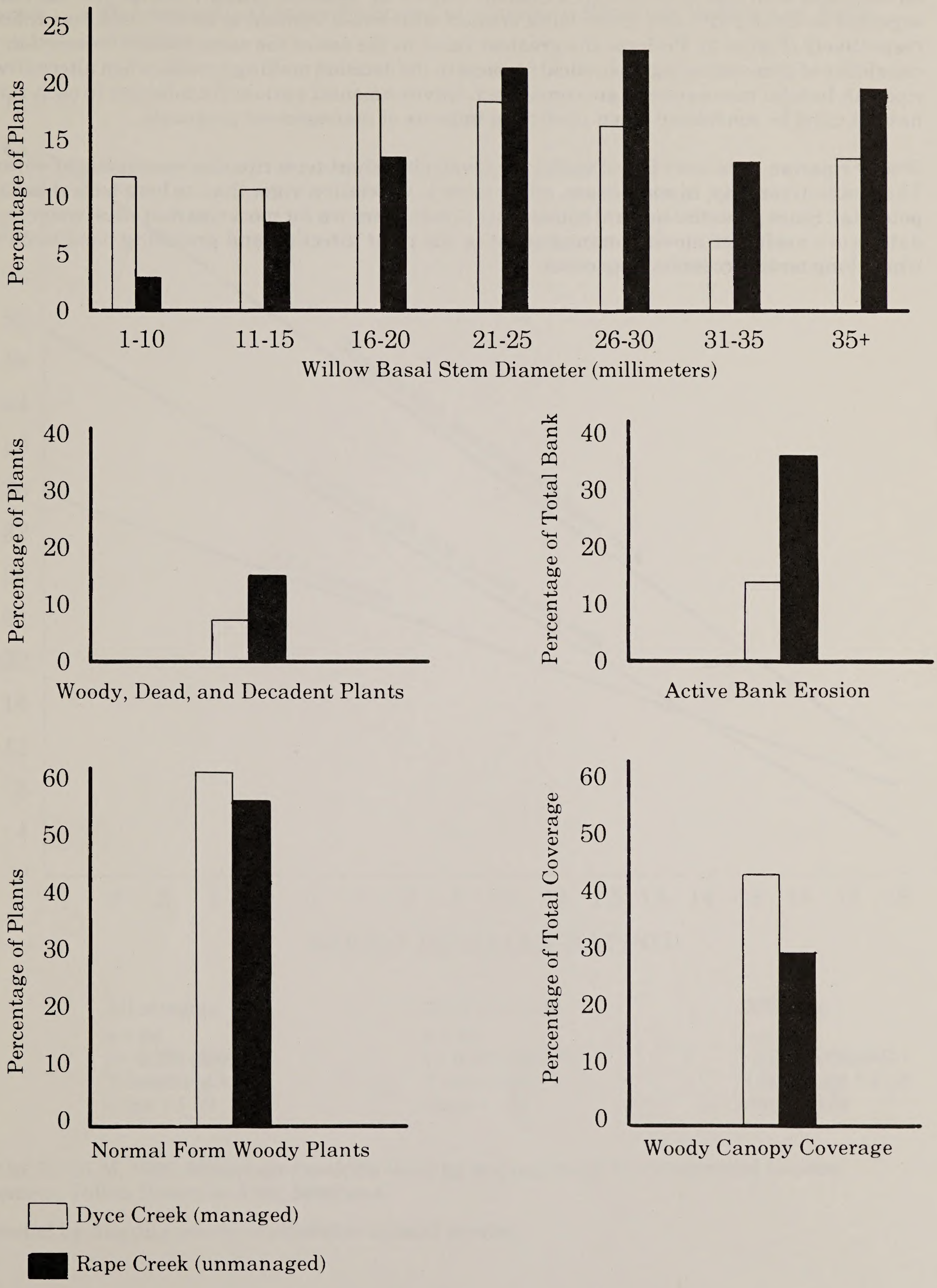
Riparian data were compared on two streams (Figure 1). Dyce Creek had been managed for approximately 10 years under a livestock grazing system moderately suited to riparian management. Hot season grazing use (7/1-9/1) occurs in only one year of three, and the stocking rate is"moderate." Rape Creek was not included in a management system. It was grazed each year during the hot season. Both streams are typical of mountain foothill riparian types. Sustained flows are 3-4 cubic feet per second, gradients are moderate (2-4%), substrates are mixed coarse gravel-fines, and woody compositions are dominated by willows with minor mixtures of other species.

Willow stem diameter distributions on Dyce Creek closely approximate a normal, bell-shaped curve (Figure 1). If diameter classes greater than 35 mm were not grouped, this would be even more true. Rape Creek diameter classes are distinctively skewed toward larger diameter (older) classes. Poor grazing management drastically changes age class composition of palatable woody species by reducing the young age classes. On Dyce Creek, young plants are more abundant than dead-decadent plants. This suggests an upward trend. Woody canopy is greater on Dyce Creek than in Rape Creek, and it is doubtless increasing, as indicated by a high percentage of reproduction. Willow could eventually be eliminated on Rape Creek as senescent plants die, and the water level declines due to channel deterioration.

When interpreting riparian data, it is important to bear in mind that on-site vegetative condition is only one of the many factors affecting channel stability. Occasionally, a stream with vigorous woody vegetation may have a high percentage of bank erosion. Upstream watershed condition, peak flow characteristics, channel alterations, and basic channel resistivity (particularly bank rock content), should then be evaluated. If a frail channel occurs, woody riparian species are of even greater value as bank protection. The question must always be asked, how much channel instability would occur if woody species were reduced? Due to the variety of other factors influencing bank stability, it may not always be possible to establish close correlations between woody canopy and percentage erosion on some streams.

Where channel vulnerability to erosion is documented by a channel inventory, such as that described by Pfankuch (1975), or by bank rock content data, fair correlations may be shown between bank erosion and riparian vegetative parameters. Cooper (1977, unpublished) observed that vegetation and bank rock content were the two riparian parameters most significant in terms of bank vulnerability to livestock damage. In the Dillon Resource Area, fair correlations between riparian rating scores and bank erosion were found (Figure 2). Riparian scores were altered for the analysis only by deleting points attributable to erosion. This correlation substantiates the relationship between vegetative vigor and stream channel stability. Where bank rock content is known, it may be possible to predict bank erosion with some certainty, given a particular riparian condition and a knowledge of upstream watershed conditions.

Figure 1. Riparian Characteristics Compared on an Unmanaged Stream and a Well Managed Stream, BLM Dillon Resource Area, Montana.

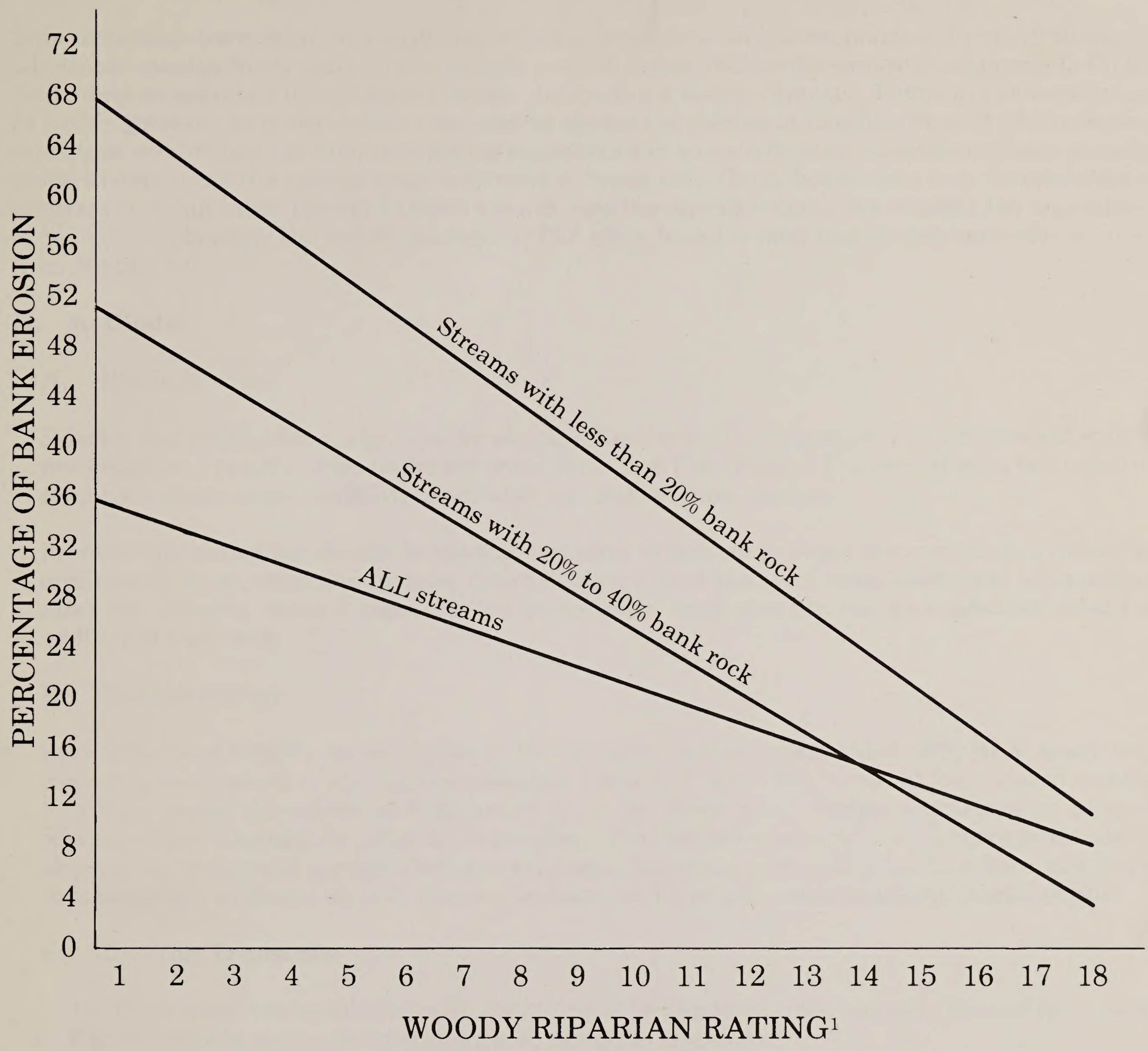


SOURCE: BLM, 1980. Mountain Foothills Grazing Management Program Environmental Impact Statement.

With bank rock contents of 20-40%, less erosion may be expected with a given riparian condition than on channels with less than 20% rock content (Figure 2). Reaches rating 7 points (low fair) may be expected to have ±32% and ±46% bank erosion where rock content is 20-40%, and less than 20%, respectively (Figure 2). Perhaps the greatest value in the use of the score erosion correlation is the capability of demonstrating theoretical impacts in the decision making process when alternatives for riparian habitat management are considered. Environmental variability inherent to each riparian habitat must be considered when predicting impacts of management proposals.

Woody riparian data were found useful for developing short-term riparian management objectives. These objectives may, in some cases, relate more to vegetation vigor than to long-term riparian site potential. Since potential natural community is rarely known for most riparian sites, woody species data prove useful for moving management in the right direction and providing conditions under which long-term succession may occur.

Figure 2. Relationship (Linear Regression) Between Riparian Rating and Bank Erosion.



All streams	20 to 40% rock	20% rock
n = 86	n = 28	n = 13
r = 0.370 (99%)	r = 0.683 (99.9%)	r = 0.455 (80-90%)
Y intercept = 36.6	Y intercept = 51.3	Y intercept = 68.9
slope = 1.59	slope = 2.71	slope = 3.38

SOURCE: BLM, 1980. Mountain Foothills Grazing Management Environmental Impact Statement, Dillon Resource Area, Montana.

[1] Adjusted by deleting points attributable to bank erosion.

Section II. WOODY RIPARIAN TREND TRANSECTS USING A COVER BOARD AND PHOTOGRAPHS

I. Purpose and Application

This represents the minimum monitoring effort to be used on all stream reaches. In many cases, no additional monitoring is done. Priorities and work force capability necessitate this approach. Cover board data *do not* relate to objectives. Rather, they indicate only an upward, downward or static trend in woody growth. In many cases, this may be all that is needed or can be afforded. If the woody inventory establishes the approximate current condition as satisfactory, cover board data are adequate to determine if a *maintenance* objective is being met. Cover board data can also indicate if progress is being made (upward trend) toward meeting specific objectives without the immediate expense of duplicating the woody inventory. The cover board is modified for use here from an idea from Nudds (1977).

II. Methods

A. Site Selection

Select a site which shows potential for change. Key on indicator species, e.g., suppressed willow reproduction. Document this under key trend factors on Field Form 2. Placement must be in open or semi-open areas where visibility is suitable, i.e., not in dense canopy.

Professional personnel should locate transect sites. Select cover board placement sites (rebar) to minimize extreme variation in cover board readings for a species. Utilize coefficient of variation after establishing about 3 transects (12 cover board readings) per reach to establish need for additional transects.

B. Establishment

Set a steel post roughly in the center of the stand to be monitored. Label with BLM study tag, including reach number and transect number. Place 5/8″ x 30″ long rebar at four desired sample locations; record directions and distances from the fence post. Compass bearings or general compass directions may be utilized. Do not place rebar behind woody debris or plant species which obscure the monitored species. Document transect locations, post and rebar locations, and livestock treatment *in detail.* Record transect location on 7½ minute quadrangle and aerial photos.

C. Reading Transects

1. Place the cover board vertically at each rebar facing toward the centrally located fence post. Center cover board on rebar station, (i.e., not off to one side).

2. Photograph the cover board (Figure 3) at each rebar site from the center post. The cover board is a 1/3 M x 2 M plywood board marked in 0.5 meter intervals of alternating colors of black and white. Include BLM Form 4412-16. Record lens size used. Record photo numbers on the field form to aid in future labeling of slides.

3. Record foliar (not canopy) vertical vegetative cover *by key species*, i.e., the proportion of the cover board segment obscured by the species. Use modified Daubenmire criteria and consider each cover board segment as a vertical quadrate. Also, record the total (sum on the form) vegetative cover (all species) for each quadrate. This is not a simple arithmetic sum of the individual species cover values, since these cover indices represent a *range*, i.e., 25 to 50%. It is possible, then, to have two species with cover values of 2 each, and yet the sum of cover still may be a 2 or 3, rather than 4.

Field Form 2. EXAMPLE OF WOODY RIPARIAN TREND TRANSECT
BLM, Dillon Resource Area, Montana.

Unit-Reach-No. RO-2-1 T. 2 S R. 8 W Sec. No. 9 SESESE
Stream Name: Camp Creek Allotment No. 0308
Date Established: 10-24-80 Name: J. Roscoe, J. Sadowski

Rebar placed 15 meters upstream of post
Rebar placed 22 meters downstream of post
Rebar placed ______ meters ______ of post
Rebar placed ______ meters ______ of post

Date	Cover Board Height	Cover Board Profile Coverage (Daubenmire Classes)[1]															
		Upstream Sta.				Downstream Sta.				Sta.				Sta.			
	Major Species	Alnus	Carex Poa		SUM	Alnus	Carex Poa		SUM				SUM				SUM
8-14-81	0.0 - 0.5 m	3	2		4	1	2		3								
	0.5 - 1.0 m	2	0		2	3	0		3								
	1.0 - 1.5 m	0	0		0	T	0		T								
	1.5 - 2.0 m	0	0		0	0	0		0								
8-20-85	0.0 - 0.5 m	0	2		2	6	1		6								
	0.5 - 1.0 m	0	0		0	5	0		5								
	1.0 - 1.5 m	T	0		T	6	0		6								
	1.5 - 2.0 m	1	0		1	6	0		6								
	0.0 - 0.5 m																
	0.5 - 1.0 m																
	1.0 - 1.5 m																
	1.5 - 2.0 m																
	0.0 - 0.5 m																
	0.5 - 1.0 m																
	1.0 - 1.5 m																
	1.5 - 2.0 m																

Photo Numbers: 1981 slides No. 35,36; 1985 slides No. 13, 14
Livestock treatment last year (1980) Grazed 5/22 to 6/30

Livestock treatment this year (1981) Grazed 5/25 to 7/1

Transect Location: 2.85 miles above Rochester Basin Road and transect No. R)-1-2; in open meadow on north side of stream; visible from road; corresponds to fishery inventory station 3.55.

Post and Rebar Locations: Upper bar left of single alder plant - 4 feet from stream

Key Trend Factors in Photos: Lack of alder regeneration plus hedging of alders - good potential for improved growth.

Note: Should add two more sample stations at this transect in 1989.

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[1] Daubenmire Classes: 0=0; T=<1; 1=1-5; 2=5-25; 3=25-50; 4=50-75; 5=75-95; 6=95-100

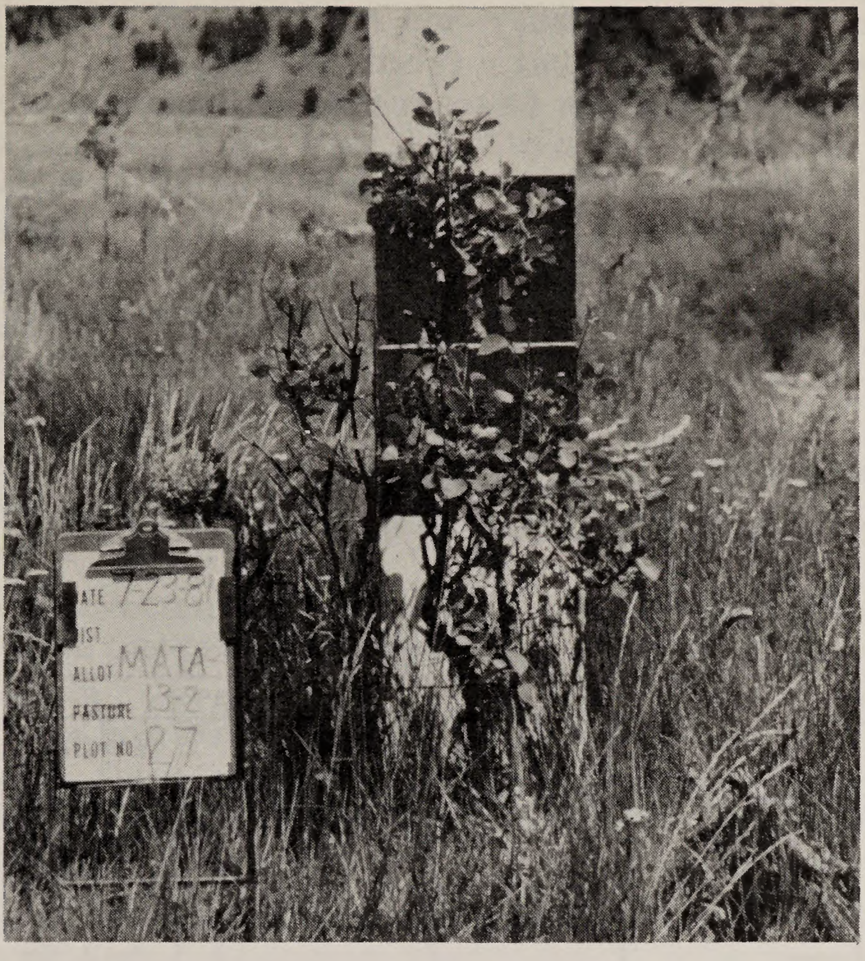


Figure 3. **Photograph of typical cover board transect on aspen. Lower segment has 25-50% aspen cover; second segment has 50-75% aspen cover; and third segment has 5-25% aspen cover.**

Cover data are recorded on the field form for each of the four height intervals (i.e., 0-0.5 m, 0.5-1.0 m) using the following modified Daubenmire criteria:

0 = 0
T = <1%
1 = 1 to 5%
2 = 5 to 25%
3 = 25 to 50%
4 = 50 to 75%
5 = 75 to 95%
6 = 95 to 100%

4. Use Kodachrome 64 film. File slides with field form and map, and label each slide with stream name, date, and transect number.

5. Transects should be completed preferably after all growth has been attained and before leaf fall (late July through early September). Where applicable, read transects during rest treatments. Record current and past years' livestock treatment on field form, even if the current years treatment is nonuse. Generally, transects are duplicated once each grazing system cycle, or at least every 5 years.

D. Computations and Evaluations

1. Separately calculate vertical foliar cover for each species by transect, and again for the stream reach and record on Field Form 3. The reach cover mean *must* be computed utilizing all the transect cover values rather than by averaging the individual transect mean cover values.

2. Utilizing a T-test (see The Lighter Side of Statistics, Eshelman et al. 1986) test the species cover value for a significant difference between the two sampling periods. If desired, each

Field Form 3. Summary and Analysis of Woody Trend
Transect Data from Field Form 2,
BLM Dillon Resource Area, Montana.

TRANSECT NO. & ADP NO.
: RO-2-1, 258W 0901
: RO-2-2, 258W 1002
: RO-3-2, 258W 0104
:
:
:
:
:

STREAM: Camp Cr

REACH: 2 and 3

SPECIES: Alnus

HEIGHT CATEGORIES (X) : All combined ___ 0-1 meters X

DATE: 8-14-81				DATE: 8-20-85			
Transect No.	Height Categories	Cover Values	Transect $\bar{X}$ Cover	Transect No.	Height Categories	Cover Values	Transect $\bar{X}$ Cover
	0.0-0.5m	37.5,3			0.0-0.5m	0,97.5	
RO-2-1	0.5-1.0m	15,37.5	23.3	RO-2-1	0.5-1.0m	0,85	45.6
	1.0-1.5m	---			1.0-1.5m	---	
	1.5-2.0m	---			1.5-2.0m	---	
	0.0-0.5m	0,0			0.0-0.5m	0.5,15	
RO2-2	0.5-1.0m	0,0	0	RO-2-2	0.5-1.0m	97.5,0	28.3
	1.0-1.5m	---			1.0-1.5m	---	
	1.5-2.0m	---			1.5-2.0m	---	
	0.0-0.5m	0,15			0.0-0.5m	0,85	
RO-3-2	0.5-1.0m	0,3	4.5	RO-3-2	0.5-1.0m	0,85	42.5
	1.0-1.5m	---			1.0-1.5m	---	
	1.5-2.0m	---			1.5-2.0m	---	
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	Reach $\bar{X}$ Cover and (Variance)	9.3 (205)			Reach $\bar{X}$ Cover and (Variance)	38.8 (2077)	

transect may be analyzed for a difference. If the notes document a unique influence on one transect (e.g., a beaver dam), it may be excluded from the calculation. When great variability in individual cover values exists, statistical analysis may not be applicable for a reach with small sample numbers.

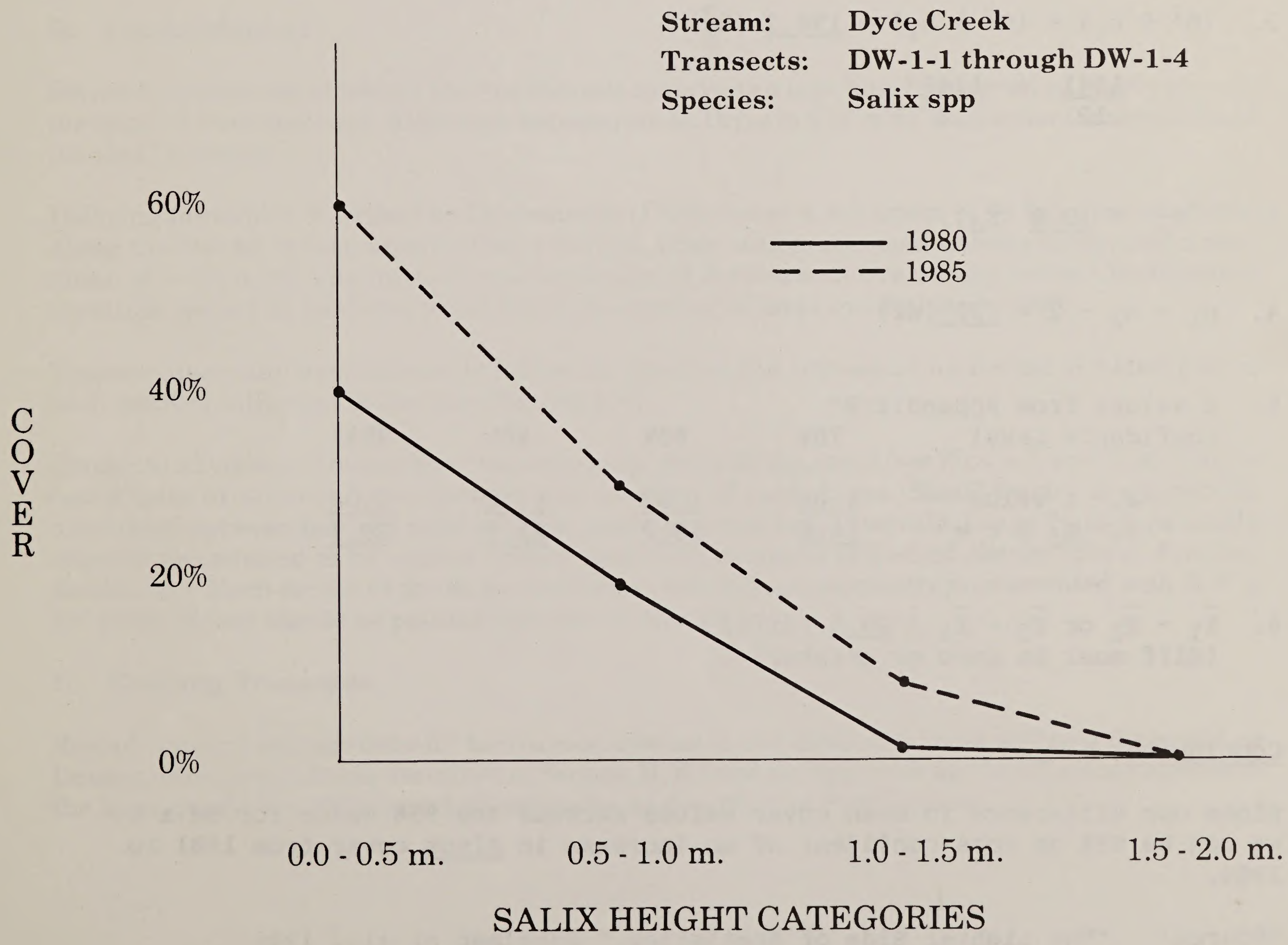
Field Form 3 provides for analysis of all height category (0-2 m) data combined, or for analysis of cover data between 0 and 1 meter high. Often the woody cover at lower heights is more sensitive to grazing and management influences.

Field Form 4 provides an example of cover analysis using data from Field Form 3, and shows a statistically significant (95% level) increase in *Alnus* cover up to 1 meter high from 1981 to 1985.

3. If desired, vertical cover may also be plotted as a vegetative profile (Figure 4). This provides a valuable demonstration tool for presentations, and allows easy comparisons of trend data.

4. The values recorded for total cover (sum on Field Form 2) includes all vegetation species, i.e., not just woody species. These data have excellent value in monitoring wildlife cover objectives for waterfowl, upland game birds, big game, or effective cover for fisheries. They are analyzed in the same way that woody cover is.

Figure 4. **Woody Vegetative Profile for Dyce Creek, BLM Dillon Resource Area, Montana.**



Field Form 4. EXAMPLE OF VERTICAL FOLIAR COVER ANALYSIS (T-test*)
BLM, Dillon Resource Area, Montana.

STREAM: Camp Creek REACH: 2, 3 TRANSECTS : RO-2-1
: RO-2-2
: RO-3-2
:
:
:
:
:

SPECIES: *Alnus*

HEIGHT CATEGORIES (X) : 0-2 meters ______ 0-1 meters X

Year 1		Year 2	
12	n_1	12	n_2
9.3	$\bar{X}_1$	38.8	$\bar{X}_2$
205	s^2	2077	s^2

1. $[(n_1-1)s_1^2 + (n_2-1)s_2^2] \div (n_1+n_2-2) = \underline{1141}\ (s^2)$

$$\frac{11 \times 205 + 11 \times 2077}{12 + 12 - 2}$$

2. $(s^2 \div n_1) + (s^2 \div n_2) = \underline{190.2}\ (s_d^2)$

$$\frac{1141}{12} + \frac{1141}{12}$$

3. $s_d^2 = \underline{13.8}\ (s_d)$

4. $n_1 + n_2 - 2 = \underline{22}$ (df)

5. t values from Appendix 9*

Confidence Level		70%	80%	90%	95%
a.	t value =	1.06	1.32	1.72	2.08
b.	$S_d \times t$ =	14.6	18.2	23.7	28.7

6. $\bar{X}_1 - \bar{X}_2$ or $\bar{X}_2 - \bar{X}_1 = \underline{29.5}$ (diff)
(diff must be zero or greater)

Conclusion:

Since our difference in mean cover values exceeds the 95% value for Sd x t, we can be 95% or more confident of an increase in *Alnus* cover from 1981 to 1985.

*Source: "The Lighter Side of Statistics," Eshelman et al., 1986

Section III. INTENSIVE RIPARIAN INVENTORIES AND MONITORING

I. Purpose and Application

This is limited to use in highest priority management areas or special study areas. These inventories generally involve the use of exclosures.

Comparison areas which are representative of common sites (riparian types) in the resource area are evaluated intensively to serve as benchmarks for establishing objectives and assessing potential. Ideally, a comparison area representative of each significant riparian site in the resource area should be intensively inventoried.

Composition data, supplemented by data on woody species vigor, soils, and channel geometry are routinely collected. Other data are collected as required.

II. Methods

A. Site Selection

Choose a location which is representative of the riparian ecological site. Consider availability of sufficient area for a 3-4 acre exclosure (where desired), plus a similar-sized area to serve as the control study. Where no exclosure is constructed, a control is not required. In some cases, both livestock and big game exclosures may be required. The control site must be comparable to the exclosure site.

B. Establishment

Set steel posts centered within the riparian site to serve as a tape line. Posts must be sturdy enough to support a stretched tape. Align tape between posts. Drive in 5/8″ x 30″ steel rebar for zero and end points of transect.

Utilizing principles described by Daubenmire (1959), orient a minimum of 40-2x5 dcm quadrates along the line for measurement of bare ground, litter, and herbaceous canopy cover, and a minimum of 6-4x8 meter quadrates for measurement of shrub-small tree canopy cover. Coefficient of variation should be analyzed to establish the number of large quadrates required.

Transect lines may have to bend to follow the riparian site, necessitating the use of a steel post at each point of inflection in the line (Figures 5, 6).

Complete a Daubenmire transect "treasure map" for both the small (see Figure 5) and large frames (see Figure 6), showing arrangement and location of each frame. Small frames are generally alternated between left and right sides at predetermined tape intervals. Large frames generally must be pre-selected to be located within consistent canopies of desired shrubs (*Salix, Populus, Betula* etc.). Each corner of the large quadrates (4x8 m) is permanently monumented with 5/8″ x 30″ rebar. Rebar should be painted fluorescent orange.

C. Reading Transects

Record canopy coverage data for herbaceous species in the small quadrates utilizing the modified Daubenmire cover criteria described in Section II. Record canopy coverage for *all* woody species in the large quadrates utilizing actual estimates as described in Part 5 below.

Figure 5. Example of a "Treasure Map" and Recordation for 2 x 5 dcm quadrates BLM Dillon Resource Area, Montana.

(Use Metric System)

Transect Number MA-18-3 Date Established 7-26-83

T. 9 S. R. 1 W. SEC. 13 , SW , ¼ of SW

Species to be monitored Herbaceous species

Length of transect 49 M . Type of witness steel posts

Distance between index points 49 M, Direction of transect, from North

to South . Distance from beginning witness post to point zero on tape 0.5 M

Point zero is marked by rebar at 0.0 M

______ . (Circle one) [✓ 2x5dcm]/4x8M Daubenmire Frame to be placed

at each 1.0 M beginning at 1 MR Total frames to be recorded 40

Soil: ______

Complete sketch of transect layout. Show frame orientation and witness posts.

FRAME # 1 mr, 2 ml, 3 mr, 4 ml, 5 mr, 6 ml, . . .

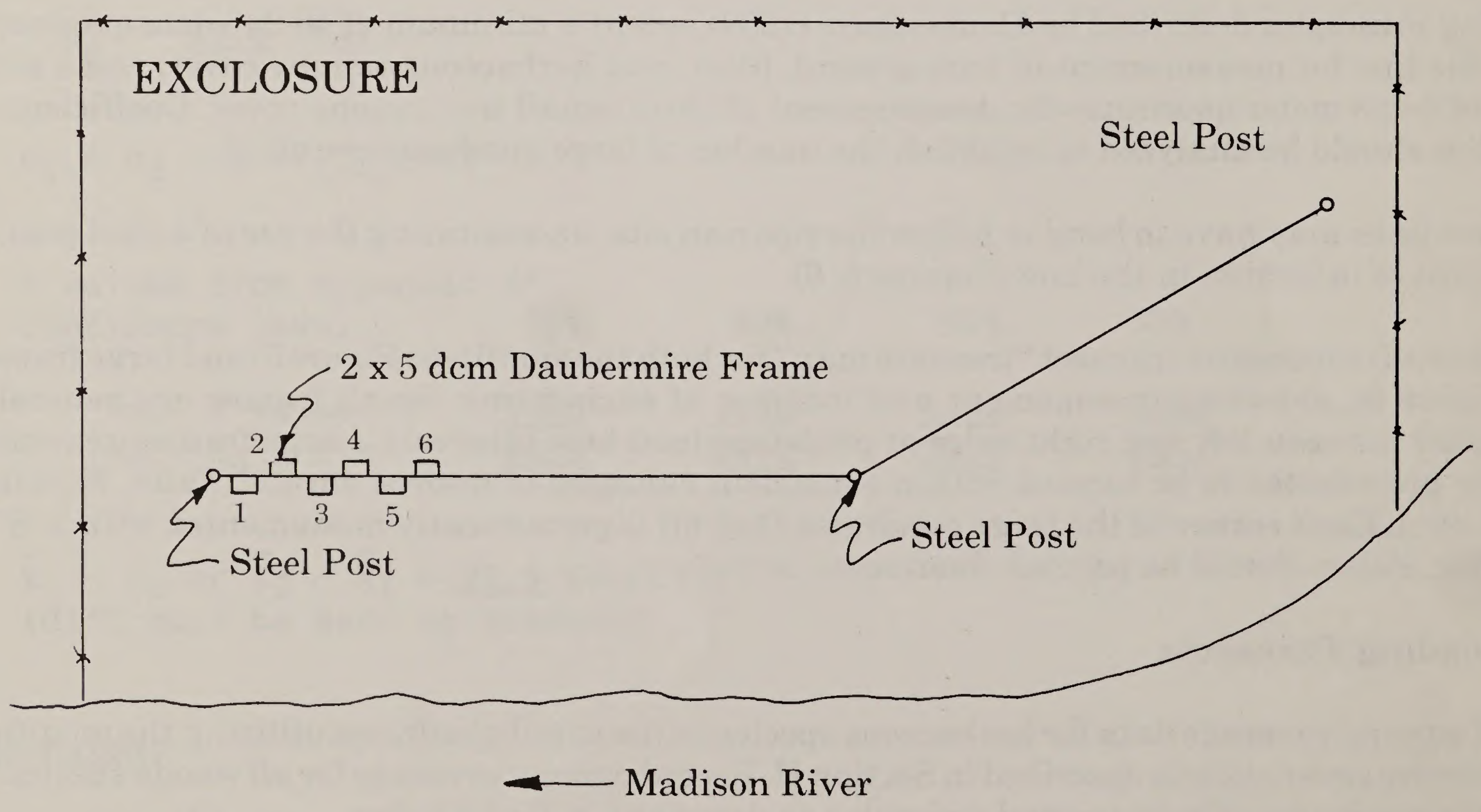

EXCLOSURE
Steel Post
2 x 5 dcm Daubermire Frame
2
4
6
1
3
5
Steel Post
Steel Post
Madison River

Figure 6. Example of "Treasure Map" and Recordation
for 4 x 8 M quadrates
BLM Dillon Resource Area, Montana.

(Use Metric System)

Transect Number MA-18-3 Date Established 3-18-83

T. 9 S. R. 1 W. SEC. 13 , SW , ¼ of SW

Species to be monitored All shrubs and trees

Length of transect 98 M . Type of witness steel posts

Distance between index points 49 M, 49 M Direction of transect, from North

to South . Distance from beginning witness post to point zero on tape 0.5 M

Point zero is marked by rebar at 0.0 M and 49.0 M

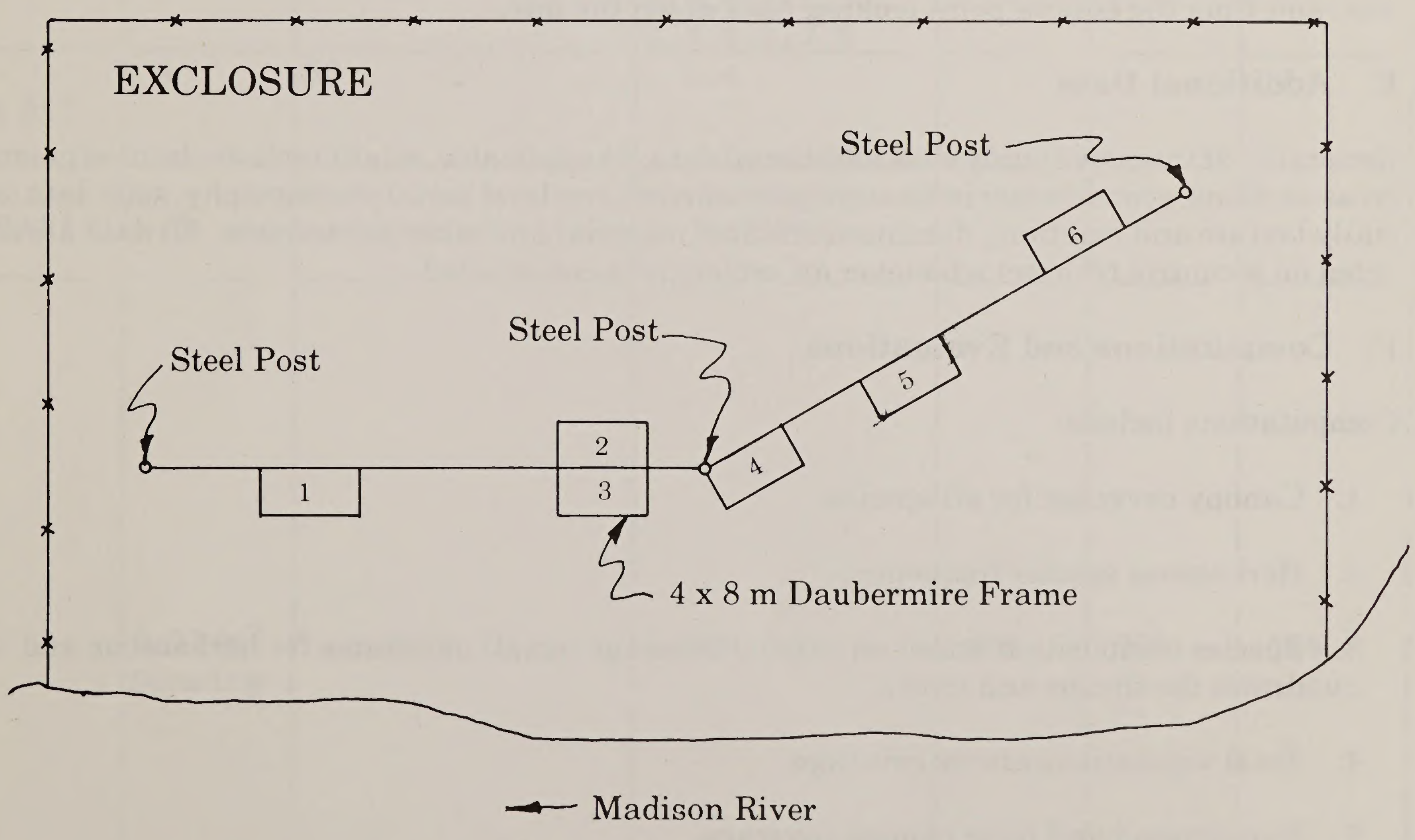
. (Circle one) 2x5dcm/[✓ 4x8M] Daubenmire Frame to be placed

at each variable beginning at 11 M right Total frames to be recorded 6

Soil:

Complete sketch of transect layout. Show frame orientation and witness posts.

FRAME #1 11-19 m right, #2 36-44 m left, #3 36-44 m right, #4 49-57 m right, #5 65-73 m right, #6 84-92 left.


EXCLOSURE
Steel Post
Steel Post
Steel Post
1
2
3
4
5
6
4 x 8 m Daubermire Frame
Madison River

In addition to canopy of all woody species, collect supplemental data. Record data separately for each large quadrate, e.g., 11-19 m right, 36-44 m left (see Field Form 5). Record data by woody species, as follows:

1. *Tally* — Count all individual shrubs and trees which are rooted in the quadrate for density computation.

2. *Dead crown* — Ocular estimate for each plant to nearest 10% for all shrubs and trees which are rooted in the quadrate.

3. *Height* — For all shrubs and trees which are rooted in the quadrate, measure height to nearest decimeter; very tall plants may be estimated.

4. *Size-age categories* — Place each plant rooted in the quadrate in one of three size-age categories based on basal stem diameter (see Section I). Complete *only* for woody species where size-age correlations are established (see Table 2). Generally only wetland species are needed.

5. *Record canopy coverage* for each shrub and tree species using an actual estimate of canopy coverage; *not* Daubenmire criteria. This provides better trend data with smaller sample sizes. In estimating canopy, it is useful to remember that in a 4x8 m quadrate, $1m^2$ of cover = 3%, $3m^2$ = 9%, $4m^2$ = 13%, etc.

D. Photographs

Standing on the tape line at the first large quadrate corner, photograph each of the remaining three corners with a cover board positioned on the rebar as is done for cover board transects (see Section II). Cover data on the cover board (profile) do not have to be recorded. Label slides according to transect number *and* quadrate number (i.e., 11-19 m right).

Take additional aspect photos, without a cover board from point zero on the transect looking up the line, and from the ending point looking back down the line.

E. Additional Data

Generally, at intensive study sites additional data, as applicable, might include channel geometry cross-sections, groundwater indicators (piezometer), low-level aerial photography, soils data (especially texture and reaction), dominant channel material and other parameters. All data are duplicated on a control transect whenever an exclosure is constructed.

F. Computations and Evaluations

Computations include:

1. Canopy coverage for all species.

2. Herbaceous species frequency.

3. Species composition based on canopy coverage (small quadrates for herbaceous and large quadrates for shrubs and trees).

4. Total vegetation canopy coverage.

5. Bare ground and litter canopy coverage.

6. Shrub and tree species density (plants per $meter^2$).

Field Form 5. SUMMARY OF LARGE (4 x 8 M) QUADRATE DATA FOR A SHRUB SPECIES, BLM Dillon Resource Area, Montana.

TRANSECT: MA-18-3 SPECIES: Salix exiqua DATE: 8/25/86

QUADRATE	TALLY	DEAD CROWN	HEIGHT	1-10	11-15	> 15	CANOPY
No. 1 (11-19M Rt)	• • • •	10, 10, 10, 40	0.8, 0.9, 0.9 1.9	• • •	•		10
No. 2 (36-44M Lt)	⊠ ⊠ ⊠ Γ.	10,0,0,0,10,0,0 0,0,0,0,0,0,0,0 0,0,0,0,0,0,10, 0,0,0,0,0,0,0, 10,0,0,0,0,0,20	2.0,1.0,0.95, 1.15,1.1,1.2, 1.3,1.6,1.4, 0.9,0.5,0.9, 0.6,0.7,1.0, 1.0,1.2,1.1, 0.8,1.7,1.6, 1.3,0.85,1.1, 1.5,1.3,1.55, 1.65,1.65,1.7, 1.7,1.9,1.8, 1.9,1.8,1.5, 1.6,1.2	⊠ Γ.	⊠ Γ.	• • • •	37
No. 3 (36-44M Rt)	⊠ •	0,10,10,0,0,10, 10,0,0,0,10	0.5,0.9,0.9, 0.9,0.5,1.5, 1.6,1.0,0.8, 2.0,1.2	⊏		• • • •	15
No. 4 (49-57M Rt)	⊠ • •	20,10,0,0,0,0, 0,0,0,0,30,0	0.9,1.0,2.2, 1.2,1.4,2.0, 1.9,0.7,1.3, 1.7,0.5,2.3	— • •	• • • •	• • •	38
No. 5 (65-73M Rt)	•	50	1.4			•	20
No. 6 (84-92M Lt)	0	------	------				0
$\bar{X}$	0.33/m^2 Density	4.5%	1.26M	48%	33%	19%	20%

7. Average dead crown for shrub and tree species.

8. Average height for shrub and tree species.

9. Proportions (%) of size-age classes for select shrub and tree species (usually only wetland species).

10. Changes in channel cross-section, including wetted width and bank full width.

11. Other parameters as required.

These data are valuable for documenting changes resulting from management or protection, as well as for documenting rates of vegetation recovery and ultimately for assessing potential. Experience has shown that woody species density, height, canopy and size-age classes often show dramatic response within 3-5 years unless major physical site changes have occurred. With the exception of size-age class proportions, other vegetation parameters are analyzed using the T-test (see Section II).

Section IV. Literature Cited

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Section V. Appendix 1

This appendix consists of copies of Field Forms 1 through 5 and Figures 5 and 6 for copying and use in the field.

Field Form 1.

WOODY RIPARIAN SURVEY, BLM Dillon Resource Area, Montana.

STREAM: ____________ STEP INTERVAL _____ QUADRATE SIZE ___ 2 x 8 M ____ 4 x 8 M ADP NO. ________
REACH NO. ________ REACH LENGTH ______ (mi.) ________(meters) BEGIN: ________ Sec. ______ T.____ R.____
DATE: __________ INVESTIGATOR: ____________ END: ________ Sec. ______ T.____ R.____
PLANT SAMPLE SIZE: ____________ NO. QUADRATES: ____________ REACH CONDITION: ____________

WOODY SPECIES	SIZE CLASSES	DENSITY TALLY	WOODY SPECIES FORM CLASSES												SIZE CLASS SUMMARY	
			< 1.5M > UNAVAILABLE		< 1.5M > NORMAL		< 1.5M > HEAVILY HEDGED		< 1.5M > DECADENT		< 1.5M > DEAD		< 1.5M > HEDGED DEAD		EACH SPECIES DENSITY/ %	ALL SPECIES DENSITY/%
															/	
															/	
	1-10 mm														/	/
															/	/
															/	/
															/	
															/	
															/	
															/	
															/	
	11-15 mm														/	/
															/	/
															/	/
															/	
															/	
															/	
															/	
															/	
	> 15 mm														/	/
															/	/
															/	/
															/	
															/	
															/	

	DROPPINGS	
	COUNT	PER HECTARE
CATTLE		
ELK		
DEER		
MOOSE		

DROPPINGS AREA = 2 m x REACH LENGTH ______m = ______m²

PERCENT HEIGHT CLASSES
< 1.5 m ___
> 1.5 m ___

RIPARIAN WIDTH (m)

AVG: __________

RIPARIAN AREA = TOTAL AVG. WIDTH ______m x TOTAL LENGTH ______m = ______m² = ______ hectares
10,000

TOTAL WOODY SPECIES DENSITY (NO/METER)	
SPECIES	DENSITY

Field Form 1. (continued)

REACH NO:

SPECIES	USE CLASS - % AVAILABLE LEADERS CLIPPED											SPECIES	PHOTOGRAPHS	
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	USE %	No.	LOCATION; DESCRIPTION
MIDPOINT	0	5.5	15.5	25.5	35.5	45.5	55.5	65.5	75.5	85.5	95.5			

SPECIES	WOODY CANOPY COVERAGE CLASSES							AVERAGE CANOPY	POTENTIAL CANOPY
	0	1-5	5-25	25-50	50-75	75-95	95-100		
MIDPOINT	0	3	15	37.5	62.5	85	97.5	Total	Total

BANK ROCK CONTENT	TALLY	PREDOMINANT SIZE ( )
65% large angular boulders 3 dcm +		
40-65% mostly small 1½-3 dcm cobble		
20-40% with most in 1-1½ dcm size		
< 20% rock, mostly gravel size		

WETTED CHANNEL WIDTH (meters, cm)

AVG:

EROSION SOURCE	ACTIVE BANK EROSION											AVERAGE EROSION	TOTAL EROSION
	0	10	20	30	40	50	60	70	80	90	100		
LIVESTOCK													
HYDROLOGIC													
HUMAN													
WILDLIFE													

NOTES:

Field Form 2. WOODY RIPARIAN TREND TRANSECT
BLM, Dillon Resource Area, Montana.

Unit-Reach-No. ______________ T. ___ R. ___ Sec. No. ____________
Stream Name: _______________________________ Allotment No. ________
Date Established: __________________ Name: _________________________

Rebar placed ___________________ meters __________________ of post
Rebar placed ___________________ meters __________________ of post
Rebar placed ___________________ meters __________________ of post
Rebar placed ___________________ meters __________________ of post

Date	Cover Board Height	Cover Board Profile Coverage (Daubenmire Classes)[1]															
	Major Species				SUM				SUM				SUM				SUM
	0.0-0.5m																
	0.5-1.0m																
	1.0-1.5m																
	1.5-2.0m																
	0.0-0.5m																
	0.5-1.0m																
	1.0-1.5m																
	1.5-2.0m																
	0.0-0.5m																
	0.5-1.0m																
	1.0-1.5m																
	1.5-2.0m																
	0.0-0.5m																
	0.5-1.0m																
	1.0-1.5m																
	1.5-2.0m																

Photo Numbers: ____
Livestock treatment last year _________________________________

Livestock treatment this year _________________________________

Transect Location:

Post and Rebar Locations:

Key Trend Factors in Photos:

Note:

---

[1] Daubenmire Classes: 0=0; T=<1; 1=1-5; 2=5-25; 3=25-50; 4=50-75; 5=75-95; 6=95-100

Field Form 3. Summary and Analysis of Woody Trend Transect Data from Field Form 2, BLM Dillon Resource Area, Montana.

TRANSECT NO. & ADP NO.
:________________
:________________
:________________
:________________
:________________
:________________
:________________
:________________

STREAM: ________________ REACH: ________________

SPECIES: ________________

HEIGHT CATEGORIES (X) : All combined ___ 0-1 meters ___

DATE:				DATE:			
Transect No.	Height Categories	Cover Values	Transect $\bar{X}$ Cover	Transect No.	Height Categories	Cover Values	Transect $\bar{X}$ Cover
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	0.0-0.5m				0.0-0.5m		
	0.5-1.0m				0.5-1.0m		
	1.0-1.5m				1.0-1.5m		
	1.5-2.0m				1.5-2.0m		
	Reach $\bar{X}$ Cover and (Variance)				Reach $\bar{X}$ Cover and (Variance)		

Field Form 4. EXAMPLE OF VERTICAL FOLIAR COVER ANALYSIS (T-test*)
BLM, Dillon Resource Area, Montana.

STREAM: ____________ REACH: ____________ TRANSECTS : ____________
: ____________
: ____________
: ____________
: ____________
: ____________
: ____________
: ____________

SPECIES: ____________

HEIGHT CATEGORIES (X) : 0-2 meters ______ 0-1 meters ____

Year 1	Year 2
____ n_1	____ n_2
____ $\bar{X}_1$	____ $\bar{X}_2$
____ s^2	____ s^2

1. $[(n_1-1)s_1^2 + (n_2-1)s_2^2] \div (n_1+n_2-2) =$ ____ (s^2)

2. $(s^2 \div n_1) + (s^2 \div n_2) =$ ____ (s_d^2)

3. $\sqrt{s_d^2} =$ ____ (s_d)

4. $n_1 + n_2 - 2 =$ ____(df)

5. t values from Appendix 9*

Confidence Level	70%	80%	90%	95%
a. t value =	____	____	____	____
b. s_d x t =	____	____	____	____

6. $\bar{X}_1 - \bar{X}_2$ or $\bar{X}_2 - \bar{X}_1 =$ ____ (diff)
(diff must be zero or greater)

Conclusion:

*Source: "The Lighter Side of Statistics," Eshelman et al., 1986

Field Form 5. SUMMARY OF LARGE (4 x 8 M) QUADRATE DATA FOR A SHRUB SPECIES, BLM Dillon Resource Area, Montana.

TRANSECT: ______________ SPECIES: ____________________ DATE: ____________

QUADRATE	TALLY	DEAD CROWN	HEIGHT	1-10	11-15	> 15	CANOPY
No. 1							
No. 2							
No. 3							
No. 4							
No. 5							
No. 6							
$\bar{X}$	Density						

Figure 5 and 6. Example of a "Treasure Map" and Recordation
for 2 x 5 dcm or 4 x 8 M quadrates
BLM Dillon Resource Area, Montana.

(Use Metric System)

Transcect Number ______________________ Date Established ______________

T. _______ R. _____ SEC. _____, _______, ¼ of ____________________

Species to be monitored ____

Length of transect __________. Type of witness ______________________

Distance between index points __________ Direction of transect, from ______

to_______. Distance from beginning witness post to point zero on tape _____

Point zero is marked by ____

_________________. (Circle one) 2x5dcm/4x8M Daubenmire Frame to be placed

at each _______ beginning at _________ Total frames to be recorded ________

Soil: ____

Complete sketch of transect layout. Show frame orientation and witness posts.

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